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Volume 10, Number 4, Fall 1989

An Industry-Wide Air Quality Survey of Bioaerosols in Ontario

Possible Asthma and Rhinitis Associated with Exposure to Ethyl-2-Cyanoacrylate

Identifying Potential Users of a Chemical in Ontario

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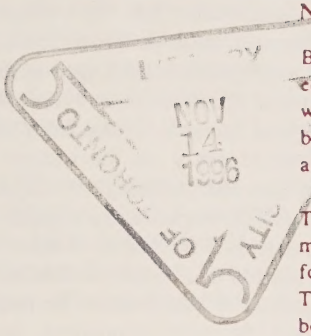

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The Editor,
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David K.N. Leong, Ph.D., P.Eng., C.I.H.,
David Fung, B.Sc.,
Mark A. Nazar, Ph.D., P.Eng., C.I.H.,
Michael Brodsky, M.Sc.

An Industry-Wide Air Quality Survey of Bioaerosols in Ontario*

Summary

This paper reports on an industry-wide air quality survey of bioaerosols at 11 workplaces in Ontario. Three types of air sampling equipment were evaluated, namely, the Andersen Two-Stage Microbial Air Sampler, midget impinger and the Biotest RCS Centrifugal Air Sampler. All three sampling methods showed similar and comparable results within the same order of magnitude at workplaces with general or low-level contamination sources. The relative advantages and disadvantages of each sampling method are discussed. The highest total bacterial

David K.N. Leong, Ph.D., P.Eng., C.I.H.,
David Fung, B.Sc.,
Mark A. Nazar, Ph.D., P. Eng., C.I.H.
Health and Safety Support Services Branch,
Ontario Ministry of Labour,
7th Floor,
400 University Avenue,
Toronto, Ontario
M7A 1T7

Michael Brodsky, M.Sc.,
Laboratory Services Branch,
Ontario Ministry of Health,
81 Resources Road,
Weston, Ontario
M9P 3T1

Introduction

Worker exposure to airborne viable micro-organisms, more recently known as bioaerosols, has been related to certain occupational diseases such as brucellosis, Q fever, anthrax and the well-publicized Legionnaire's disease. However, bioaerosol hazards have been given lesser attention than chemical hazards in the field of occupational hygiene. More recently, in the indoor air quality investigations at offices and buildings, occupational hygienists have generally begun to recognize the need for considering the possible association of microbial causes with the complaints of odour, headaches and eye and respiratory irritation that cannot be rationalized in terms of low-level chemical exposures. In responding to the greater interest in this area, the ACGIH Committee on Bioaerosol drafted a document entitled "Bioaerosols, Airborne Viable Micro-organisms in Office Environments: Sampling Protocol and Analytical Procedures."[1] The document is intended to help in assessing the hygiene status of an office environment and the likelihood of a workplace illness such as hypersensitive pneumonitis, humidifier fever and allergies being related to bioaerosols. Assessment of bioaerosol hazard is appropriate when the association of reasonably well-defined clinical symptoms with local sources of chemical irritants has been ruled out. A specific hands-on workshop sponsored by the University of Michigan is now being offered in the United States for training occupational hygiene personnel on the assessment of bioaerosol hazards in the workplace.

Although there has been considerable interest in the occupational hygiene assessment of airborne bioaerosols, the evaluation methods and procedures are, however, less well defined and there is a general lack of data on the bioaerosol levels in workplaces other than the office buildings. An ongoing research program has been initiated in the Health and Safety Support Services Branch, Ontario Ministry of Labour, to:

*Presented at the XXII International Congress on Occupational Health, September 27 - October 2, 1987. Sydney, Australia.

levels were found in a chicken slaughterhouse, hospital laundry and one of the hospital bacteriology laboratories. The highest total fungal levels were found in the chicken slaughterhouse, hospital laundry and food bacteriology laboratory, but they were relatively lower than the corresponding total bacterial levels. Human activities and movement could contribute to bioaerosol levels.

Key Words: bioaerosol, air quality, total bacterial level, total fungal level, Andersen Sampler, impinger, Biotest Sampler.

a) explore and test the air sampling and counting techniques;
b) determine the appropriate sampling equipment for preliminary investigation and follow-up assessment;
c) determine the appropriate sampling durations for bioaerosol sampling by different equipment in different work situations;
d) relate bioaerosol concentrations to individual work tasks;
e) estimate exposure levels based on bioaerosol concentrations and exposure durations related to the various work tasks;
f) establish a data base of industry-wide bioaerosol levels for promoting occupational health education and training, hazard control review and health protection; and, hopefully
g) relate bioaerosol exposure levels to illness rates for different job occupations in an attempt to derive the occupational exposure guidelines.

This paper reports the preliminary findings of our phase one study on the industry-wide air quality surveys of bioaerosols in Ontario.

Scope

Eleven workplaces were surveyed, including two non-bacteriology laboratories, three bacteriology laboratories, an animal research facility, an animal shelter, a hospital dental clinic, a hospital laundry, a poultry processing facility and a fur hat manufacturing shop. Three types of air sampling equipment were used, namely, the Andersen Two-Stage Microbial Air Sampler, midget impinger and the Biotest RCS Centrifugal Air Sampler. Various air samples were taken at selected work locations and, to a lesser extent, on workers (i.e. personal sampling) for the determination of total bacteria and total fungi generally and, where appropriate, the gram negative rods, total coliforms, bacillus, staphylococci and thermophylic actinomycetes as well. All air samples were incubated and the colonies counted at the Environmental Bacteriology Laboratory, Ontario Ministry of Health.

Methods

Air Sampling Instruments

a) Short-Term Sampling

The Andersen Two-Stage Microbial Air Sampler was used mainly for determining short-term bioaerosol levels. Each sample was taken at a calibrated airflow of 28.3

Lpm, usually for a sampling duration of 5-60 minutes, depending upon the quantity of airborne viable particles present. The sampler itself is basically a multi-orifice cascade impactor with two standard 100 × 15 mm plastic, disposable Petri dishes (Fisher Scientific, Part No. 8-757-13), each pre-filled with 20 mL of a suitable general-purpose agar medium, as given in Table 1. The impactor separates airborne viable particles into respirable and non-respirable size ranges with the 50 per cent cut-off diameter at eight microns for spherical particles of unit density. In order to facilitate data comparison with other sampling techniques, total counts were used to express the air sampling results in the unit of total colony-forming units (CFU) per cubic metre of air sampled. Both orifice stages of the impactor were cleaned with mild detergent and then warm water before and after each survey. Just before taking an air sample, all surfaces were wiped with 70 per cent isopropyl alcohol by means of a gauze pad.

Table 1 **Sample Incubation**

Bioaerosol	Incubating Condition
Total bacteria	48 Hrs., 32°C
Gram negative rods	24 Hrs., 35°C
Total coliforms	24 Hrs., 35°C
Bacillus	24 Hrs., 35°C
Staphylococci	24 Hrs., 35°C
Thermophilic Actinomycetes	72 Hrs., 55°C
Total fungi	72 Hrs., 22°C

Also employed in some surveys for side-by-side sampling with an Andersen Microbial Sampler was a hand-held, battery-operated Biotest RCS Centrifugal Air Sampler inserted with a plastic strip containing a culture medium. Both types of agar strips, GK-A (TSA-agar) and HS (rose-bengal-agar), supplied by the instrument manufacturer, were used for sampling total bacteria and total fungi respectively. The airborne viable particles were impacted by centrifugal force onto the sampling medium. Each short-term sample was taken at an airflow of 40.0 Lpm for a sampling duration of usually 30 seconds to eight minutes. All surfaces of the impeller drum assembly were wiped with 70 per cent isopropyl alcohol before each sample was taken.

b) Time-Weighted Average Sampling

The impinger sampling technique was used to determine

the bioaerosol concentrations over sampling periods up to an hour. Sequential samples may be taken to obtain a better estimate of the time-weighted average concentration. Each sample was taken by drawing air at a flow-rate of 1.0 Lpm through 10 mL of phosphate buffer physiological saline solution. Only a single solution medium was needed for sampling the various types of airborne viable particles as multiple analyses of a sample solution can be performed by mixing aliquots with the required agar media and incubating under the required conditions. Care was taken to sterilize impingers, which were steam autoclaved for 15 minutes at 121°C, 15 psig before and after each survey and then wrapped in kraft paper for storage. In order to avoid cross contamination of samples, each impinger was restricted to a single use each day in a survey.

Air Sampling Strategy

Sequential air samples were generally taken during work activities at work locations where there were potential exposures to bioaerosols. Whenever feasible, personal samples on workers or air samples close to a worker's breathing zone were taken by the impinger sampling technique or by a Biotest RCS Centrifugal Air Sampler. In addition, a few air samples were taken at selected control sites remote from the contamination sources being investigated. As practised in other occupational hygiene surveys, two blank samples for each sampling method used in each survey were submitted, together with the air samples, to the laboratory for analyses. One of the blanks in each set was handled and shipped in the same manner as the air samples except that no air was drawn through it.

Sample Inoculation

a) Agar-Plate Samples

The agar-plate samples obtained by means of an Andersen Microbial Air Sampler were incubated for 24–72 hours at 22°–55°C, depending on the types of microbial colonies to be counted. The various incubating conditions are given in Table 1.

b) Agar-Strip Samples

The agar-strip samples obtained by means of a Biotest RCS Centrifugal Air Sampler were incubated for 48 hours at 32°C for the determination of total bacteria, and for 72 hours at 22°C for total fungi.

c) Impinger Samples

An aliquot (1–5 mL) of impinger sample solution was mixed thoroughly in a test tube with 17–85 mL of tryptone glucose yeast agar or oxytetracycline gentamicin yeast extract glucose agar for determining total bacteria or total fungi. The inoculated medium was poured into a Petri dish and allowed to solidify.

In the determination of gram negative rods or total coliforms, 0.1 mL of impinger sample solution was spread evenly onto the surface of 15 mL solidified McConkey agar medium. The inoculated agar plates were incubated under the same conditions as given in Table 1 for the types of microbial colonies (e.g. 48 hours at 32°C for total bacteria) counted.

Enumeration of Colonies

Microbial colonies were enumerated by means of a Darkfield Quebec Colony Counter, manufactured by the American Optical. Occasionally, when a sample agar plate was overpopulated with more than 250–300 colonies, the 'positive hole' method was used to count the colonies.[2]

Results and Discussion

Sampler Suitability and Comparison of Results

The use of an Andersen Microbial Sampler for air monitoring of viable micro-organisms is a well-known technique. Because of its capability to sample at high airflow rate of 1 cfm (i.e. 28.3 Lpm), short-term air samples can be obtained to follow up medical, clinical or occupational hygiene investigations and to help assess whether the work-related illness is likely due to the viable micro-organisms. The technique is, however, limited to the use of different sampling media and incubating conditions for determining the levels of different types of bioaerosols. Since a single air sample cannot be used for multiple analyses, the etiologic microbial agent used as a more relevant air quality indicator has to be determined, or at least suspected, before initiating an air quality survey.

Likewise, the high airflow rate of 40 Lpm offered by a Biotest RCS Centrifugal Air Sampler allows short-term sampling. The technique is also limited to the use of specific agar-medium strips and incubating conditions for sampling a given type of bioaerosol. Being a battery-operated and hand-held instrument, the Biotest RCS Centrifugal Air Sampler offers the additional advantage of obtaining short-term air samples at the

worker's breathing zone, particularly in workplaces such as operating rooms, dental clinics, etc., where the accessed space is rather limited. A major disadvantage to the user is, however, the limited shelf-life of the agar-medium strips supplied by the instrument manufacturer. Unless the instrument is used quite frequently for routine sampling or the user has some facilities for refilling the empty strips with the self-prepared agar medium required, it may not be cost-effective operationally for field application. By means of generated monodisperse aerosols between one and 25 microns containing a sodium fluorescein tracer, the recent work of Kwan and Bierman[3] suggested a possible underestimation of aerosol concentrations compared with an Andersen Sampler due to the decreased collection efficiency for particles less than 20 microns. Another disadvantage is the difficulty in checking the airflow rate directly.

Microbial sampling by means of a standard midget impinger appears to be a promising alternative, particularly for personal sampling. It is also a practical and convenient technique for field applications as only a single sampling medium is needed for sampling different types of bioaerosols. Furthermore, multiple analyses of an impinger sample solution for the various types of bioaerosols can be performed by mixing aliquots with the required agar media and incubating under the required conditions. Because of the low airflow rate of 1.0 Lpm employed, the method is generally more useful for extended-period sampling and may be more appropriate for occupational hygiene assessment when occupational exposure guidelines based on an eight-hour workday or a 40-hour work-week are available. It is, however, less suitable for investigative purposes than an Andersen Microbial Sampler or a Biotest RCS Centrifugal Air Sampler. These samplers allow more samples to be taken at a greater number of sampling locations in a wider area for a given period of investigation.

All three methods were noted (Tables 2 and 3) to give similar and comparable results, generally within the same order of magnitude for total bacterial and total fungal levels at workplaces (e.g. occupational hygiene laboratory, aquatic toxicology laboratory, food bacteriology laboratory, hospital animal research facility, hospital dental clinic, fur hat manufacturing shop) with either general or low-level contamination sources. When the air sampling results associated with different work tasks in a hospital microbiology laboratory or

an animal shelter are compared, the Biotest RCS Centrifugal Sampler appeared to show the relative changes in total bacterial levels more distinctively than the other two samplers (Table 2). This is understandable in view of the ease of air sampling at a worker's breathing zone with a hand-held battery-operated instrument.

Exceptionally higher or lower results were sometimes noted for the impinger method, which requires an additional analytical step of mixing an aliquot of impinger sample solution with an agar medium by either the pour-plate or spread-plate technique. These occasional discrepancies more likely reflect the greater needs for precaution and judgement in determining the appropriate sampling durations for samples taken at contaminated workplaces (e.g. chicken slaughterhouse, laundry, etc.) and in taking the appropriate aliquots of sample solutions for inoculation and incubation.

Total Bacterial Levels

The highest total bacterial levels were found in the chicken slaughterhouse, the hospital laundry and one of the hospital bacteriology laboratories (Table 2).

The chicken slaughterhouse is located in the downtown metropolitan area of a large city. Chickens from the receiving dock on the ground floor were transferred via a conveyor to the defeathering/slaughtering and eviscerating departments in the basement. Some of the processed chickens were returned to the cutting department on the ground floor for cutting and retail sale. Two sets of air samples were taken during and after the peak business periods. Loading and defeathering of chickens were noted to stop at 12:00 noon. The total bacterial concentrations during the peak business period were so high that the upper colony-counting limits for the three methods used were exceeded in all the samples taken. The concentrations remained high after the peak business period in the afternoon as the upper colony-counting limit for the impinger method was again exceeded. However, more definitive levels were detected by the Andersen Sampler, using the 'positive hole' method to estimate the colonies. The mean concentrations for chicken loading, defeathering and eviscerating after the peak business period were respectively 2,400, 6,300 and 1,200 CFU/m^3. The corresponding levels during the peak business period would presumably be 10,000–20,000 CFU/m^3.

The hospital laundry occupies two floors. The linen bags were opened for sorting on the ground floor. The

Table 2	Mean Total Bacterial Levels (CFU/m³)			
Workplace	**Task**	**Andersen**	**Biotest**	**Impinger**
Chicken Slaughterhouse	Loading Chicken			
	During Peak	>4,200	>5,300	>21,000
	After Peak	2,400	—	>21,000
	Defeathering			
	During Peak	>4,200	>5,310	>21,000
	After Peak	6,300	—	>21,000
	Eviscerating			
	During Peak	>3,500	>5,310	>21,000
	After Peak	1,200	—	>21,000
Hospital Laundry	Linen Sorting & Bagging	730	—	570
	At Sorter's BZ	—	—	2,700
	Washing	70	—	50
	At Washman's BZ	—	—	120
	Ironing	120	—	260
	Linen Decaling	130	—	1,500
Hospital Microbiology Lab	Sample Inoculation	130	510	—
	Plate Reading	220	250	—
	Hematology Test	130	120	—
	Sample Reception	40	90	—
Fur Hat Manufacturing Shop	Fur Moulding	220	270	220
	General Shop Activities	210	270	130
	Dry Sweeping of Floor	—	—	>25,000
Animal Shelter	Feeding, Cleaning, etc.			
	At Adopting Pound	1,110	1,250	—
	At Holding Pound	240	620	—
	General Activities	220	460	—
	Office Reception Activities	100	690	—
Hospital Animal Research Facility	Cage Washing	200	—	120
	Animal Feeding & Maintenance	50	—	350
	Corridor Activities	200	—	500

sorted linens were bagged and sent via a chute to the washing department in the basement for washing, ironing and decaling. The highest concentration of 2,700 CFU/m³ was detected by the impinger method at the sorter's breathing zone. The mean levels for linen sorting and bagging operations were 570 CFU/m³ in area samples taken by impingers and 730 CFU/m³ by the

Andersen Sampler. Lower levels were generally noted for washing, ironing and decaling operations.

The merit of using a hand-held battery-operated instrument for practical evaluation of bioaerosol concentrations at, or close to, the workers' breathing zones was best demonstrated in the hospital microbiology laboratory survey. The total bacterial concentrations determined by a Biotest RCS Centrifugal Sampler for sample inoculation, plate reading, hematology tests and sample reception were 510, 250, 120 and 90 CFU/m^3 respectively. The corresponding levels determined by the Andersen Sampler were 130, 220, 130 and 40 CFU/m^3. The relative changes in concentrations with respect to work activities were more distinctively reflected in the former set of measurements.

Dry sweeping has been well known to occupational hygienists as a poor work practice that causes high dust concentrations. The same finding was noted in the fur hat manufacturing shop visited. While the total bacterial levels for the fur-moulding operation and general shop activities were 40-460 CFU/m^3, dry sweeping of the shop floor with a broom in the afternoon resulted in a very high concentration greater than 25,000 CFU/m^3.

The significance of human activity and movement as a contributing factor to total bacterial level was shown in the animal shelter/care facility survey. The levels were several times higher at the animal adoption holding pound (1,100–1,250 CFU/m^3) than at the adjacent general holding pound (240–620 CFU/m^3). The former was open to the public whereas the latter was isolated to put the incoming animals in quarantine. A similar finding was also noted in the hospital animal research unit survey, where the total bacterial concentrations in the corridors (200–500 CFU/m^3) outside the unit were higher than the levels within the unit (50–350 CFU/m^3).

The total bacterial levels in the occupational hygiene laboratory, aquatic toxicology unit and food bacteriology laboratory were minimal and never exceeded 140 CFU/m^3.

Total Fungal Levels

The highest total fungal levels were found in the chicken slaughterhouse, the hospital laundry and the food bacteriology laboratory, but they were relatively lower than the corresponding total bacterial levels. The highest concentration of 460 CFU/m^3 was detected by the impinger method during the peak business period at

the receiving dock of the chicken slaughterhouse (Table 3). The level dropped significantly to 60 CFU/m^3 in the afternoon. The changes in concentrations were random between the morning and afternoon samples taken at the defeathering, eviscerating and cutting departments (range: 30–290 CFU/m^3). Similar levels were detected in the sorting department of the hospital laundry (15–320 CFU/m^3) by the impinger method, and during sample handling and inoculation (50–230 CFU/m^3) in a food bacteriology laboratory by the Andersen Sampler. The levels at other workplaces were minimal and below 90 CFU/m^3.

Table 3 Total Fungal, Total Coliform and Gram-Negative Rod Levels (CFU/m^3) at Chicken Slaughterhouse

Task	Total Fungi*	Total Coliform**	Gram-Negative ROD**
Loading Chicken			
During peak	460	1,530–1,580	1,580–2,120
After peak	60	890–960	1,770–2,260
Defeathering			
During peak	110	35–71	71–85
After peak	230	120–212	431–495
Eviscerating			
During peak	110	21–35	35–78
After peak	260	35–37	57–106
Cutting			
During peak	240	—	—
After peak	<30	—	—
Cutter BZ			
During peak	30	—	—
After peak	60	—	—

* Impinger
** Andersen

Total Coliform Levels

The highest concentrations of 1,530–1,580 CFU/m^3 were detected by the Andersen Sampler during the peak business period at the receiving dock of the chicken slaughterhouse (Table 3). The levels dropped to 890–960 CFU/m^3 in the afternoon. The changes in concentrations were random between the morning and afternoon samples taken at the defeathering, eviscerating and

cutting departments (range: 21–212 CFU/m^3). The total coliform levels at other workplaces were minimal and below 50 CFU/m^3.

Gram-Negative Rod Levels

In contrast to the decreases in total fungal and total coliform concentrations noted after the peak business period at the receiving dock of the chicken slaughterhouse, the gram-negative rod levels determined by the Andersen Sampler remained high throughout the day (mean: 1,930 CFU/m^3, range: 1,580–2,260 CFU/m^3). Lower levels (35–495 CFU/m^3) were detected at the defeathering and eviscerating departments (Table 3). Gram-negative rods were non-detectable (i.e. $<$ 14 CFU/m^3) at other workplaces. The only exceptions were two of the air samples taken on the sensitivity test bench of a hospital microbiology laboratory and taken outside the laboratory entrance, where high ($>$2,620 CFU/m^3) and detectable (28 CFU/m^3) levels of gram-negative rods were noted.

Conclusions

Detailed studies in livestock-handling facilities are being continued. Based on the preliminary findings, it is concluded that:

1. All three bioaerosol sampling methods used in this study were noted to give similar and comparable results, generally within the same order of magnitude at workplaces with either general or low-level contamination sources.
2. Both the Andersen Microbial Sampler and the Biotest RCS Centrifugal Sampler are more suitable for medical, clinical or occupational hygiene investigations when the etiologic bioaerosol agent is known or suspected.
3. The Biotest RCS Centrifugal Sampler appeared to reflect most distinctively the relative changes in levels associated with the work tasks and work practices. It offers the advantage of short-term air sampling at the worker's breathing zone, particularly in workplaces where the accessed space is rather limited.
4. The impinger method appeared to be a promising alternative for area as well as personal sampling. It allows extend-period sampling and multiple analyses of an impinger sample solution. The method may be more appropriate for assessment of occupational exposures when the TWA guidelines are available.

There are greater needs, however, for precaution and judgement in determining the appropriate sampling durations for samples taken at contaminated workplaces and in taking the appropriate sample solution aliquots for sample inoculation and incubation.

5. The highest total bacterial levels were found in the chicken slaughterhouse, the hospital laundry and one of the hospital bacteriology laboratories.

6. The highest total fungal levels were found in the chicken slaughterhouse, the hospital laundry and the food bacteriology laboratory, but they were relatively lower than the corresponding total bacterial levels.

Résumé

Le présent document fait état d'une étude de la qualité de l'air dans toute l'industrie qui porte sur l'utilisation de bioaérosols dans les lieux de travail en Ontario. Trois genres d'équipement d'échantillonneurs d'air ont été évalués, notamment, l'échantillonneur en deux phases d'air microbien Andersen, le midget-impinger (appareil à impact miniature) et l'échantillonneur d'air centrifuge Biotest RCS. Ces trois méthodes d'échantillonnage ont donné des résultats semblables et comparables, pour un même ordre de grandeur, dans les lieux de travail où l'on trouve des sources de contamination générales ou faibles. Les avantages et les désavantages respectifs de chacune des ces méthodes d'échantillonnage sont à discuter. Les niveaux de bactéries les plus élevés ont été trouvés dans un abattoir de volaille, dans la lessive d'un hôpital et dans les laboratoires de bactériologie de l'hopital. Les niveaux fongiques les plus élevés ont été trouvés dans l'abattoir de volaille, dans la lessive de l'hôpital et dans le laboratoire de bactériologie alimentaire. Toutefois, ils étaient relativement moins élevés que l'ensemble des niveaux de bactéries correspondants. Le travail et les mouvements de l'homme pourraient avoir une incidence sur les niveaux de bioaérosols dans l'air.

References

[1]Morey PR, Otten J, Burge H, et al. Bioaerosols, Airborne Viable Micro-organisms in Office Environments: Sampling Protocol and Analytical Procedures. App Ind Hygiene 1986; 4:R19–R23.

[2]Andersen Samplers Inc. Operating Manual for Andersen Samplers Inc. Viable (Microbial) Particle Sizing Samplers. 1984.

[3]Kwan JK, Biermann AH. Study of the Performance of an Air Sampler for Biological Agents. Presented at the American Industrial Hygiene Conference, June 1987. Montreal, Canada.

Marie L. Roy, M.D., Ph.D.
Sidney R. Siu, P.Eng., C.I.H., M.D.
Robert Wong, M.B., Ch.B., FRCP(C)

Possible Asthma and Rhinitis Associated with Exposure to Ethyl-2-Cyanoacrylate

Summary

Ethyl-2-cyanocrylate (ECA) is used in many industries as a permanently bonding, high-strength adhesive (e.g. Krazy Glue®). ECA may cause skin and eye irritation, and there have been two previous reports that it caused respiratory tract sensitization.

This paper is a case report of ECA use at two companies, the first manufacturing

Dr. Marie L. Roy, M.D., Ph.D.,
Senior Medical Toxicologist,
Health and Safety Support Services Branch,
Ontario Ministry of Labour,
7th Floor,
400 University Avenue,
Toronto, Ontario
M7A 1T7

Dr. Sidney R. Siu, P.Eng., C.I.H., M.D.,
Senior Medical Consultant,
Health and Safety Support Services Branch,
Ontario Ministry of Labour,
205 Oxford Street E.,
London, Ontario
N6A 5G6

Robert Wong, M.B., Ch.B., FRCP(C),
Medical Consultant,
Health and Safety Support Services Branch,
Ontario Ministry of Labour,
2 Robert Speck Parkway,
Mississauga, Ontario
L4Z 1H8

Introduction

Occupational asthma may be caused by some low molecular weight reactive chemical monomers such as isocyanates, anhydrides, formaldehyde and monomers in epoxy resins.[1,2] Unsubstituted acrylate monomers such as methyl methacrylate have long been known to cause skin sensitization[3,4] and there have been recent reports that methyl methacrylate caused respiratory tract sensitization.[5,6]

Ethyl-2-cyanoacrylate (ECA) is a liquid of low vapour pressure, which, in thin films, polymerizes almost instantaneously on contact with water vapour. This cyanoacrylate ester has widespread use as a permanently bonding high-strength adhesive in many industries (automotive, plastics, electronics, aerospace), and it has been used experimentally as a surgical adhesive.[7,8,9]

It is well known that ECA is a moderate skin, but a severe eye, irritant. Eye and mucous membrane irritation begin in the range of 2 to 3 ppm ECA, and transient blurred vision and lacrimation may occur at higher levels.[10] Cases of contact dermatitis were also reported.[11,12,13]

Recently, there has been one published case report of respiratory tract sensitization due to home use of ECA glue.[14] The diagnosis in this case was established by bronchial inhalation challenge to the instant glue. There is also a conference report of five cases of respiratory tract sensitization due to cyanoacrylate-based adhesives, although ECA is not mentioned by name.[6]

This paper reports two separate incidents where possible asthma and rhinitis could be attributed to the use of ECA-containing adhesive.

Company Manufacturing Radar Detecting Equipment and Satellite Receivers

A 39-year-old previously healthy woman had been employed for five months glueing together electronic components at a company that manufactures radar detecting equipment and satellite receivers. The company employs 400 production workers, and, of these, eight

radar detecting equipment and satellite receivers and the second manufacturing communication assemblies for full-face respirators. Three previously healthy employees in the two companies developed asthma-like symptoms in response to ECA-containing adhesive after less than six months' exposure. One of the employees had significantly decreased FEV_1 when this was measured on one occasion while the employee was still working. The exposure of all three employees was discontinued shortly after the onset of symptoms.

Key Words: ethyl-2-cyanoacrylate, occupational asthma, rhinitis, glue, electronics companies

to nine workers are employed at a table where the adhesive containing ECA is used. No local exhaust was provided and, because of the precision requirement of the glueing operation, the employees at the ECA glueing table must hold the component pieces to be glued six to 10 inches from their eyes.

The employee has no history of allergy or asthma. A grandfather had asthma but no parent or sibling has asthma. After four to five months of glueing work, the employee developed a chronic rhinitis, and subsequent symptoms of nasal itching and burning, along with a dry irritating cough and some chest tightness, would develop within an hour of beginning the glueing operation. Within an hour of leaving the plant, the cough and chest tightness would usually disappear, although the rhinitis symptoms would persist.

The relevant pulmonary function tests performed while the patient was still working were FEV_1 1.31 L (54 per cent predicted), FVC 1.97 L (72 per cent predicted), and diffusing capacity normal.

After one month of being away from her job, her rhinitis had completely resolved and she had no more cough, wheeze or chest tightness. Repeat pulmonary function studies were: FEV_1 2.04 L (83 per cent predicted) and FVC 2.40 L (87 per cent predicted). A histamine inhalation challenge test performed at this time did not demonstrate increased bronchial reactivity.

The employee subsequently returned to work in a non-exposed work area and did not experience any further respiratory symptoms.

Air sampling for ECA was carried out both in the breathing zone of glueing table operators and in the background of the glueing table. Airborne concentrations of ECA were determined by collection of ECA on Tenax absorbent tubes, through which work-room air was drawn at the rate of 1L per minute for 30 minutes. Desorption of ECA was carried out by eluting each section of the Tenax tubes with 1 ml of acetone. The analysis was performed by gas chromatography equipped with a thermionic specific detector maintained at 220°C. While the analytical procedure does not distinguish between polymerized ECA or monomeric ECA, the polymerized ECA would not have been sampled due to its low vapour pressure.

The results of air sampling were all well below the manufacturer's exposure guideline of 2 ppm, and the highest level measured was 0.2 ppm in the glueing table background. The relative humidity in the plant was measured and found to be 32 to 43 per cent.

Electronics Company

A 33-year-old previously healthy female was directly involved with a glueing operation in a small electronics company. The company employs seven workers in the manufacture of communication assemblies for full-face respirators. From time to time, the employee was required to glue the electronic component assembly to the head set. The adhesive containing ECA is dispensed from a 30-ml bottle in droplets onto the areas of contact. None of the workers recalled any history of spills of adhesive in the plant. No local exhaust was provided and no gloves were used.

The employee had no history of allergy, but had smoked 10 cigarettes daily for 10 years. She initially developed symptoms of choking, heavy coughing and a sensation of difficulty in breathing after working with the adhesive for three to four months. Symptoms subsided within 30 minutes of being removed from exposure.

After the incident, the worker was not directly involved in the glueing operation. However, her symptoms recurred several times in the next few months whenever the adhesive was used in proximity to her workbench. Occasionally, the symptoms were associated with headache and an unpleasant taste in her mouth.

The glueing was done outdoors until a local exhaust ventilation system was developed and implemented. Air sampling for ECA was carried out on the first day of indoor operation. The air sampling technician witnessed and described the symptoms of the worker as follows:

> After approximately 30 minutes of glueing, one of the employees began coughing and choking severely while experiencing a significant tightness in the chest area. After leaving the work area, the aforementioned symptoms slowly eased . . .

Another worker, a 35-year-old previously asymptomatic female, developed similar symptoms after exposure to the adhesive for a period of five months of employment. She had smoked 20 cigarettes daily for 12 years.

Pulmonary function testing of both workers was carried out approximately two months after their last exposure. Both workers exhibited only mild obstruction, which could have been due to the effect of cigarette smoking, and the two workers both declined challenge testing.

Discussion

The diagnosis of occupational asthma can be confirmed by monitoring FEV_1 and/or peak expiratory flow rate measurements in relation to work exposure. Non-specific bronchial reactivity as assessed by histamine or methacholine inhalation testing has been shown to be increased in occupational asthma. Serial measurements of non-specific bronchial reactivity in relation to exposure may also help in relating the symptoms to the workplace. Specific inhalation challenge to the suspect agent in specialized respirology laboratories is a precise method to confirm sensitization. In such challenge testing the sensitized individual will demonstrate immediate and/or late asthmatic responses to the suspect agent.

For the patient employed in the company manufacturing radar detecting equipment and satellite receivers, bronchial reactivity was not assessed at the time the subject was symptomatic, but, the normal result of the bronchial reactivity test performed a few weeks after last exposure is in keeping with a previous study, which suggested that increased non-specific bronchial reactivity is likely to be a result rather than a predisposing factor in occupational asthma.[15] Specific inhalation challenge to the ECA-containing adhesive could not be arranged for this individual.

The brand of glue used in all three companies contained chemicals other than ECA, including chemicals known to be skin sensitizers, e.g. hydroquinone (up to 1,000 ppm) and methyl methacrylate derivatives (up to 5 per cent). Methyl methacrylate itself has also been reported to be a respiratory tract sensitizer, but was present in the glue in relatively small amounts.

It is known that ECA may degrade over time to produce formaldehyde, which is another potential sensitizer; however, this occurs slowly.[16]

The relative humidity of the electronics company workplace (45 per cent) and of the company manufacturing radar equipment and satellite receivers (32 to 43 per cent) was below the relative humidity level of 55 per cent, which has been recommended by manufacturers of cyanoacrylate glues. Thus, as suggested by Calnan,[10] there may not have been enough water vapour in the atmosphere of the electronics company to polymerize any vaporized cyanoacrylate.

Unfortunately, the two workers in the electronics company who had symptoms of respiratory tract sensitization were unable to undergo immediate respiratory challenge testing. As far as we are aware, a RAST panel containing suitable hapten-protein complexes for the

glue components is also not available. The two workers were removed from direct exposure at the first signs of possible sensitization, and the normal pulmonary function tests taken two months later are consistent with, but do not prove, occupational asthma.

Our findings are suggestive of the possibility that ECA-containing adhesive may be a respiratory tract sensitizer especially under conditions of low humidity even when air levels of ECA are below manufacturers' guidelines.

Résumé

Le CNO-2-acrylate d'éthyle* est utilisé dans un grand nombre d'industries comme adhésif permanent extrêmement puissant (par exemple, Krazy Glue[MC]). Le CNO-2-acrylate d'éthyle peut provoquer une irritation de la peau et des yeux; deux rapports précédents indiquent que cette substance a entraîné une sensibilisation des voies respiratoires.

Le présent document constitue un rapport d'un cas d'exposition au CNO-2-acrylate d'éthyle utilisé dans deux compagnies, la première fabriquant de l'équipement de détection de radar et des récepteurs de satellite, la seconde des pièces d'appareils de communication pour des respirateurs couvre-visage. Trois employés de ces compagnies qui étaient auparavant en bonne santé ont présenté des symptômes similaires à ceux de l'asthme après moins de six mois d'exposition à un adhésif contenant du CNO-2-acrylate d'éthyle. Le VEM_1† de l'un de ces employés avait considérablement diminué lorsqu'il a été mesuré une fois pendant que l'employé était encore à l'emploi de la compagnie. L'exposition de ces trois employés à ce composé a été interrompue peu après l'apparition des premiers symptômes.

*L'appellation anglaise de ce composé est le 'Ethyl-2-cyanoacrylate (ECA).'

†L'équivalent anglais de VEM_1 est FEV_1.

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References

[1]Parkes WR. Occupational Lung Disorders. Toronto: Butterworths, 1982; 419–422.

[2]Furon D, Cantineau A, Frimat P. Asthma, Occupa-

tional. In: Parmeggiani L, ed. Encyclopaedia of Occupational Health and Safety. 3rd ed. Geneva: ILO, 1983; 201–4.

[3]Clayton GD, Clayton FE. Patty's Industrial Hygiene and Toxicology. 3rd ed., vol. 2A. Toronto: John Wiley & Sons, 1981; 2291–3.

[4]Fisher AA. Contact Dermatitis. 2nd ed. Philadelphia: Lea and Febiger, 1973; 82, 185.

[5]Pickering CAC, Bainbridge D, Birtwhistle IH, Griffiths DL. Occupational Asthma Due to Methyl Methacrylate in an Orthopaedic Theatre Sister. Brit Med J 1986; 292(6532):1362–3.

[6]Lozewicz S, Davison AG, Hopkirk A, et al. Occupational Asthma Due to Methyl Methacrylate and Cyanoacrylates. Thorax 1984; 39(9): 712–13.

[7]Blais P, Campbell RW. Cyanoacrylates in Medicine. Can Med Assoc J 1982; 126: 227–8.

[8]Mickey BE, Samson D. Neurosurgical Applications of the Cyanoacrylate Adhesives. Clin Neurosurg 1981; 28: 429–44.

[9]Citrin P, Doscher W, Wise L, Margolis IB. Control of Needle-Hole Bleeding with Ethyl 2-Cyanoacrylate Glue (Krazy Glue). J Vasc Surg 1985; 2(3): 488–90.

[10]McGee WA, Oglesby FL, Raleigh RL, Fassett DW. The Determination of a Sensory Response to Alkyl 2-Cyanoacrylate Vapor in Air. AIHAJ 1968; 29: 558–61.

[11]Calnan CD. Cyanoacrylate Dermatitis. Contact Dermatitis 1979; 5: 165–7.

[12]Shelly ED, Shelly WB. Chronic Dermatitis Simulating Small Plaque Parapsoriasis Due to Cyanoacrylate Adhesive Used on Fingernails. JAMA 1984; 252(17); 2455–6.

[13]Fisher AA. Reactions to Cyanoacrylate Adhesives: "Instant Glue." Cutis 1985; 35(1): 18, 20, 22, 46, 58.

[14]Kopp SK, McKay RT, Moller DR, Cassedy K, Brooks SM. Asthma and Rhinitis Due to Ethyl 2-

Cyanoacrylate Instant Glue. Ann Intern Med 1985; 102(5): 613–15.

[15]Lam S, Wong R. Yeung M. Nonspecific Bronchial Reactivity in Occupational Asthma. J Allergy Clin Immunol 1979; 63(1): 28–34.

[16]Kulkarni RK, Hanks GA, Pani KC, Leonard F. The In Vivo Metabolic Degradation of Poly(methyl cyanoacrylate) via Thiocyanate. J Biomed Mater Res 1967; 1: 11–16.

Gary M. Liss, M.D., M.S., FRCP(C)

Identifying Potential Users of a Chemical in Ontario

Summary

This report describes some of the difficulties involved in identifying industrial facilities in Ontario that are potential users of a given chemical. It is noted that the task would be easier if there were a data base that contained the chemical inventories of the companies. An attempt to evaluate the accuracy of questionnaire responses to chemical use was possible using Ministry of Labour air quality assessments.

Key Words: chemicals, identification of chemical users, WHMIS, cohorts

Gary M. Liss, M.D., M.S., FRCP(C),
Health Studies Service,
Policy and Regulations Branch,
Ontario Ministry of Labour,
8th Floor,
400 University Avenue,
Toronto, Ontario
M7A 1T7

Introduction

Little has been written about how one can identify facilities or groups of workers potentially exposed to a chemical of interest. Steenland et al[1] previously detailed steps in deciding which facilities to include in a cohort study, discussing issues of estimating sample size and power, levels of exposure and adequacy of personnel records. In their ethylene oxide example an industrial sector on which to focus was readily apparent, and existing literature was used to identify potential sites.

In 1986 an increased incidence of lung and liver tumours in mice and benign mammary tumours in rats was reported from an inhalation study of methylene chloride.[2] Coincidentally, an investigation was completed soon thereafter into concerns about (breast) cancer morbidity at a lamp manufacturing plant in Ontario. An excess of breast cancers was observed among women in an area with potential for exposure to methylene chloride;[3] however, exposure to methylene chloride was not a concern prior to this study. The Minister of Labour (MOL) received a joint request from the unions and company involved concerning the possibility of further study of the chronic health effects of the compound.

Because the numbers of workers exposed to methylene chloride, presently or in the past, were not known, an investigation was carried out by the Health Studies Service to determine the feasibility of carrying out such a study. The investigation[4] found that there were few facilities with large numbers of exposed workers, that most users had started using methylene chloride in recent years, and that in large companies there was no efficient way to find exposed subgroups (perhaps numbering in the hundreds) within a plant population of tens of thousands, findings similar to a feasibility investigation carried out in the United States by the National Cancer Institute.[5,6]

The purpose of this report is not to focus on methylene chloride itself or the characteristics of those facilities identified,[4] but rather it was thought useful to illustrate

the (potentially time-consuming) *preliminary* steps that may be required in order to identify facilities that are potential users of a compound of interest in Ontario if there is no readily available data base of users or distributing facilities (the problems may be similar elsewhere).

Estimate of Numbers

The National Cancer Institute (NCI) examined the feasibility of conducting a U.S. study of mortality among workers exposed to methylene chloride.[5] The target cohort size was 10,000 workers. The NCI investigators calculated that, with assumptions about the age and average length of follow-up of the cohort, a study group of this size would be able to detect minimum odds ratios of 1.4 for lung cancer, 1.9 for pancreatic cancer, 2.1 for leukemia, and 3.0 for liver cancer, with 90 per cent power. After efforts to identify suitable exposed groups for potential inclusion, only an estimated 4,480 white male production workers (in seven companies) were found;[6] this was not considered large enough for the study to provide adequate statistical power. As a result of these determinations, the study was not undertaken (Zahm S., personal communication).

In Ontario it was estimated that with similar age and length of follow-up assumptions, and a less ambitious target of 5,000 workers and 80 per cent power, the estimated minimum detectable relative risks for these cancer types were 1.5, 2.3, 2.3 and 6.2 respectively, and 2.1 for breast cancer based on 1,000 females.

Populations and Contacts

Methylene chloride is not produced in Canada; on the other hand, of the seven candidate companies identified in the NCI feasibility study in the U.S., four (contributing about 1,500 of the 4,480 workers) were producers.[6]

There being no producers in Canada, it was necessary to enquire of the importers and distributors to identify end-users. Ideally, one wished to find a manageable number of reasonably large plants to approach; that is, for a plant population to be included there must be a large enough number of exposed employees to merit the effort of data collection, aside from having to ascertain whether there were suitable records to identify former and current workers. NCI in the U.S. targetted those facilities employing more than 200 employees only.[6]

Steps Taken in Identification of Candidate Facilities (in Ontario)

The major components of the feasibility study involved:

I. Sources to identify worksites using methylene chloride;
II. Development of a questionnaire survey for distribution to distributors and end-users regarding the numbers of exposed workers;
III. Special joint meeting with the Canadian Auto Workers Union (CAW) and motor vehicle manufacturers;
IV. Follow-up telephone interviews; and
V. Assessment of accuracy of survey responses.

I. Sources to Identify Worksites with Potential for Methylene Chloride Exposure

The major industry sectors in which consumption of methylene chloride and the presence of exposed workers could be expected were initially identified from the previous NCI efforts.

A number of sources were utilized to identify worksites potentially using methylene chloride:

a) Ministry of Labour Sources:

i) The Health and Safety Support Services Branch (HSSSB) maintains a computerized data base of sites at which air sampling for methylene chloride had been performed since 1984–85;
ii) a listing from Industrial Health and Safety Branch computerized data base of facilities known to use methylene chloride; and
iii) data assembled by the Program Development Unit.

b) Other Sources:

During 1987 the Health Studies Service contacted and/or held meetings with various groups, including labour unions and industry and trade associations (Appendix 1) in order to develop a data base of facilities potentially using methylene chloride and to obtain outside input and advice.

i) Trade Associations: Membership lists were obtained from the Canadian Manufacturers of Chemical Specialties Association and Canadian Paint and Coatings Association. All member facilities were added to the list of potential users, with the following exclusions: companies outside Ontario were excluded, as were very small companies, where this was indicated on the membership lists by the associations' directors.

ii) Importers and Distributors: One major importer was a willing participant. The Canadian Association of Chemical Distributors (CACD) was also contacted and the membership list obtained. The initial approach to CACD members required relying on the distributors to send copies of the survey questionnaire to their customers, although, ultimately, when contacted directly, most distributors did supply customer lists (see below).

iii) The 1986 Chemical Buyers' Guide (Southam Publications) provided a listing of companies supplying methylene chloride. Also consulted were the 1986 Guide to Canadian Manufacturers and the 1981 Canadian Key Business Directory (Dun and Bradstreet Canada), which lists company names and addresses by Standard Industrial Codes.

It should be noted that some end-users obtained methylene chloride from more than one supplier, and therefore the same end-user often appeared in several customer lists. Eventually, a merged list from the various sources was formed for further analysis.

II. Questionnaire Development

A questionnaire was developed and designed to elicit information on whether the facility is or has ever been engaged in methylene chloride use or distribution; the processes or uses involved; number of employees exposed; total number of employees at the facility; years during which methylene chloride was used; and the availability of industrial hygiene records and work histories. An initial draft of the questionnaire was circulated in August 1987 to the labour, industry and trade association groups (Appendix 1). The final version was mailed out in December 1987, following revision and distribution for further comments, to the list of over 100 users initially identified (prior to receipt of distributors' customer lists) and, in January 1988, to members of the CACD. Nonresponders to the original mailing were followed up with telephone calls, and when customer lists were obtained from distributors, nonresponders from these lists were followed up with telephone calls and/or second copies of the questionnaires.

III Motor Vehicle Manufacturers: A Special Case

Based on the NCI experience in the U.S., it was known that methylene chloride had been used by motor vehicle manufacturers in operations such as spray painting and cleaning of spray booths, but the CAW and the manufacturers were uncertain about what job titles were involved and whether past workers could be identified within the plant populations numbering in the tens of thousands. Therefore, a separate, joint meeting was held in February 1988 with representatives from the CAW, the three manufacturing companies and the Motor Vehicle Manufacturers Association (MVMA) to develop a procedure for estimating the numbers of exposed workers and whether they could be identified.

IV. Telephone Interview

All respondents reporting 10 or more employees exposed to methylene chloride were contacted by telephone to verify the process, the numbers of exposed employees and the year that the compound was first used. From all those reporting 25 or more exposed employees and methylene chloride use prior to 1978 (chosen to give a minimum of approximately 10 years of follow-up), more detailed information was obtained on processes, job titles, numbers of employees working with methylene chloride at a time, estimate of turnover, estimate of total numbers exposed over time, estimate of proportion of exposed workers that was female, and exposure data, if available.

V. Attempt to Evaluate Accuracy

To attempt to evaluate the accuracy of the survey responses, the questionnaire responses from the subset of facilities known from MOL air quality assessments to have used methylene chloride were further examined, using the HSSSB data base as the 'gold standard' for comparison.

Findings

A total of 280 companies were identified as potential users and distributors of methylene chloride. Table 1 presents the number of companies by survey status as of December 1988. Only three (one per cent) indicated their refusal to respond to the survey when contacted, and 10 others did not respond.

After telephone follow-up, responses were obtained from 114 (98 per cent) of the 116 initial companies,

and from 100 per cent of the distributors. Of the additional 145 companies identified from the distributors' lists, responses were obtained from 135 (93 per cent).

Table 1 **Number and Percent of Candidate Companies by Interview Outcome Status**

	Number	(%)
Total	**280**	**(100)**
Never used or distributed methylene chloride	32	(11.4)
Out-of-business	5	(1.8)
Refusal	3	(1.1)
Nonworking telephone/Could not be located	10	(3.6)
No response as yet	10	(3.6)
Users and distributors		
Prior to 1978	106	
During or after 1978	100	
Start date unknown	14	
Total (users and distributors)	220	(78.6)

Of the 20 distributors contacted (19 from the CACD; one additional major distributor did not belong to CACD at the time the membership list was obtained), 11 indicated that they did not distribute methylene chloride. Of the remaining nine, one refused to answer the questionnaire or to pass it on to customers, but indicated that very little of the solvent was handled (i.e. a few drums). Of the remaining eight distributors, responses pertaining to their own employees were received from them all, and customer lists were received from six (75 per cent). Some end-users often appeared on more than one distributor list.

Interview Findings

There were 220 users and distributors of methylene chloride identified. Table 2 presents the number of companies by first year of methylene chloride use, number of employees currently in methylene chloride processes, and processes or uses reported (more than one process could be reported by a company). Most companies had fewer than 10 exposed employees and about half of them dated first use from 1978 or after. The most frequent specific uses reported for methylene chloride were as solvent, paint remover and degreaser.

Table 2 Number of Companies by First Year of Methylene Chloride Use, Number of Employees Currently in Methylene Chloride Processes, and Processes Reported

First Year of Use				
Total	Before 1967	1968–1977	After 1977	Unkn
220	45	61	100	14

Number of Employees (first use before 1978 only)			
Total	< 10	10–24	>=25
106	82	14	10

Process or Use: General*	
Manufacture or filling of MC-products	84
Cleaning of equipment	86

Process or Use: Specific*	
Solvent use	74
Paint remover	61
Degreasing	40
Adhesives	38
Aerosol	21
Polyurethane foam	20
Printing	7
Electronics	5
Pharmaceuticals	4

*More than one process could be reported by a company (some questionnaires had general or specific but not both responses completed)

Potential Candidate Companies (25 or More Exposed Workers)

More detailed information was obtained from those companies reporting 25 or more exposed workers, with first use before 1978.[4] Including the three automobile manufacturers, there were 10 companies with 25 or more employees exposed at a time; eight of these estimated that there were more than 100 exposed employees in total over time. The proportion of females among exposed workers was estimated to be less than 10 per cent at six of these facilities, 25 per cent at one, and over 50 per cent at three.

Caution should be exercised in interpreting the numbers of exposed workers because the quality and availability of personnel records (examination of which could have represented a next step) were not reviewed. Thus, companies may not have suitable personnel records and seniority lists for determining former workers. Moreover, even if records exist, it may not be possible, as encountered with the automobile manufacturers (see below), to identify those workers exposed in the

past without going through all the personnel files at the facility.

Assessment of Accuracy of Survey Responses

Forty-two companies were known from the HSSSB data base to have had air samples analysed for methylene chloride during 1984-1986. As a check on the accuracy of the answers to the survey, the responses of these companies were examined. Of the 42 companies (one of which had three facilities), responses were not obtained from six (three were out of business, the telephone was not in service for two, and one company refused to respond even with follow-up phone contact). Of the remaining 36, 33 (92 per cent) responded affirmatively to the question 'Does your company use or has it ever used methylene chloride?' One of these was initially not aware of what product contained methylene chloride, but was subsequently able to confirm its use from the processes or job locations that had been sampled. Three responded 'no' to the question regarding current or previous use: The methylene chloride operation had been moved out of one facility in 1984, three years before completion of the questionnaire; in a second company, four of 40 employees were intermittently exposed to a lacquer containing methylene chloride, but management was not aware of its contents; and at a third company, personnel were not initially aware that methylene chloride had been used. On further searching, a Material Safety Data Sheet for a solvent containing methylene chloride was found, but this was used in a different department from the one sampled; management could not find a product containing methylene chloride in the department sampled.

Availability of exposure information: From the survey responses and telephone interviews, it appeared that there was limited industrial hygiene data available, and, as expected, most measurements had been carried out in the past 10 years. Of those companies reporting methylene chloride use before 1978, only 35 (34 per cent) responded that exposures had ever been measured. In the NCI survey, it was noted that the industries with the largest numbers of monitoring data were producers who had the lowest exposures, and the companies with higher exposures had few historical exposure measurements.[6]

Discussion

Response Rate: The response to the questionnaire of the initial potential users to whom it had been mailed directly by the Health Studies Service of the MOL was about 75 per cent before telephone follow-up, but after persistent contact, the response (98 per cent) was excellent. The response rate was slightly lower (93 per cent) from the additional users subsequently identified through distributors' lists. Based on the review of the subset of facilities known to have used methylene chloride, the responses appeared quite accurate, with greater than 90 per cent indicating affirmatively that the compound was used. However, as noted above, there was some evidence of a lack of awareness of product contents, which is not surprising. It is not known to what extent one can extrapolate these findings regarding accuracy of responses to other facilities.

It also remains unknown how many users were missed because of the lack of customer lists from two distributors. The fact that some users obtained methylene chloride from more than one distributor suggests, but certainly does not confirm, that few large users were missed.

Numbers of Exposed Workers: Ten unstudied companies (seven, excluding automobile manufacturers) were identified as having 25 or more exposed employees at a time. Excluding automobile manufacturers, it was estimated that there were 100 or more exposed workers, over time, at five of the other seven, with a total at these sites of about 1,000. Again, as noted, since records at these facilities were not reviewed, it is not known whether adequate personnel records were available.

The Automobile Industry has used methylene chloride in a number of ways, including as an ingredient in spray paints, as a degreaser and as a solvent. Unfortunately, discussions with the CAW/auto firm teams led to the conclusion that these were not good candidate companies for study. The exposed group was usually a small proportion of a large plant with perhaps 5,000-10,000 production workers in each facility (the number over the past 20 years could be twice as large). The teams were not able to find a systematic way to identify those workers previously in exposed jobs, other than by resorting to manually reviewing or abstracting the records for the entire plant. The casual or intermittent and poorly documented use of methylene chloride as a degreaser/general cleaner over time makes quantification of exposure difficult. Thus, these facilities cannot

provide suitable candidate populations; Zahm et al reached similar conclusions in the U.S.[6]

Other potential industrial sectors in which facilities were not systematically sought included furniture stripping and pharmaceutical companies (although some facilities from each sector were included in customer lists). The former operations are typically very small, and there was no trade association to facilitate communication. The latter industry is characterized by multiple chemicals and batch operations with intermittent use, when months may elapse between exposure to a given chemical.[6]

Other Comments/Discussion:

First, the HSSSB air sampling data base proved to be very helpful, both in refreshing employers' memories about departments in which methylene chloride had been used and in verifying the accuracy of responses.

Second, officials and investigators contacted in Alberta and Quebec (Appendix 1) were not optimistic about attempting to identify large exposed populations in their provinces.

Third, trying to identify, survey and follow up methylene chloride users was a time-consuming process. In the future, a similar task would be much easier *if knowledge of at least the presence or absence (Y/N) of use*, regardless of quantity or of numbers of exposed employees, were available initially. Such an initial guide could be provided, for example, by developing a mechanism for obtaining chemical inventories under WHMIS (Workplace Hazardous Materials Information System).

Fourth, the numbers of exposed workers in the companies identified have been estimated at 1,000 (excluding the auto companies). This population did not meet the tentative Ontario target of 5,000, and, certainly, is nowhere near the NCI target of 10,000. This is not surprising given the much greater American industrial base and the absence of producers in Canada.

An additional concern is what proportion of those exposed would be female since breast cancer was a cancer site of interest; at most plants, fewer than half of those persons exposed were estimated to be female. Finally, the exposed populations identified would generally not have adequate industrial hygiene data to estimate past exposure.

An additional source that could be used within the manufacturing sector as a supplement to, or in the

absence of, trade association data is the Statistics Canada Census of Manufacturing, which compiles data by SIC code on companies responding to this census.

Review

No existing data base was found that could provide comprehensive listings, by chemical, to begin the initial steps of determining which companies might have large numbers of employees exposed currently or in the past. Greater than one-half of the person-hours required to carry out this feasibility survey was spent in following up companies by telephone. However, a considerable amount of time was consumed by meetings, writing letters, telephone contacts and so on in order to develop a data base of potential distributors and users. As noted above, in the future, such an undertaking for other compounds of interest would be much easier if knowledge of the presence or use of the compound under study (even merely Y/N, regardless of quantities or numbers of employees) were available in a central repository of company-specific inventories, for example, under WHMIS. This comment, it is realized, is not without logistical and resource implications.

Résumé

Le présent rapport fait la description de quelques-unes des difficultés rencontrées dans l'identification d'installations industrielles en Ontario qui sont des utilisatrices possibles d'un produit chimique donné. Il est à remarquer que la tâche serait plus facile s'il y avait une base de données qui comportait les inventaires de produits chimiques utilisés par les compagnies. Un effort pour évaluer l'exactitude des réponses figurant dans le questionnaire relatif à l'usage de produits chimiques a été possible en recourant aux évaluations de la qualité de l'air effectuées par le ministère du Travail.

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Dr. G.J. Stopps provided advice throughout the initial organization and discussions. Jim Turk, Kim Perrotta, Gary Cwitco, Jim Gill, Dr. Roland Hosein and Bruce Waechter attended initial meetings and provided helpful suggestions. Frank Krammer performed the initial power calculations. Irene Rule and Rose Pagliaro maintained the data base and carried out telephone follow-up. Dominica U assisted with the word processing. Special thanks are due to the teams of CAW-Auto manufacturer representatives involved in determining exposed jobs.

References

[1]Steenland K, Stayner L, Greife A. Assessing the Feasibility of Retrospective Cohort Studies. Am J Ind Med 1987; 12:419–430.

[2]NTP. National Toxicology Program, 1986: NTP Technical Report on the Toxicology and Carcinogenesis Studies of Dichloromethane (methylene chloride) (CAS No. 75-09-2) in F344/N Rats and B6C3F$_1$ Mice (inhalation studies). NIH publication No. 86-2562.

[3]Shannon HS, Haines T, Bernholz C, et al. Cancer Morbidity in Lamp Manufacturing Workers. Am J Ind Med 1988; 14:281–290.

[4]Liss GM. Methylene Chloride Use Survey: Feasibility Report. Ministry of Labour, 1988.

[5]Zahm SH, Stewart P, Blair A. A Study of Mortality Among Workers Exposed to Methylene Chloride. Draft Protocol. National Cancer Institute. Bethesda, Maryland, April 1987.

[6]Zahm SH, Stewart PA, Blair A. A Study of Mortality Among Workers Exposed to Methylene Chloride. Feasibility Report. National Cancer Institute. Bethesda, Maryland, May 1987.

Appendix 1

Groups with Whom the Health Studies Service Met or Had Contact

Labour*:
United Electrical Workers
Communications and Electrical Workers of Canada
CAW (National Automobile, Aerospace and Agricultural Implement Workers Union of Canada)

Industry Groups and Trade Associations:
Canadian General Electric
Motor Vehicle Manufacturers Association
Dow Chemical Canada Inc
Canadian Chemical Producers Association
Canadian Paint and Coatings Association
Canadian Manufacturers of Chemical Specialties Association
Canadian Association of Chemical Distributors

*Representatives of these unions made further enquiries to other unions.

Other Government and Research Agencies:

Shelia Hoar Zahm, Ph.D., National Cancer Institute, U.S.A.

Dr. Claire Infante-Rivard, Epidemiologist, McGill University, Montreal

Brian C. Alleyne, M.Sc., Manager, Occupational Epidemiology, Alberta Community and Occupational Health

IRSST (Institut de recherche en santé et en sécurité du travail du Québec)

Ontario Working Exposure Guidelines (WEGS) for Chemical and Biological Agents

Within the regulatory framework under the *Occupational Health and Safety Act*, work exposures to toxic substances are controlled largely by enforcing the exposure limits set in designated substance regulations and the exposure values of 584 substances in a generic health regulation (i.e. Ontario Regulation 654/86 respecting Control of Exposure to Biological or Chemical Agents). The exposure values are largely adopted from recognized exposure guidelines, including the ACGIH TLVs. In addition, Ontario working exposure guidelines are being developed in the Health and Safety Support Services Branch (HSSSB) of the Ministry of Labour to meet the increasing need for assessing work exposures to other chemical and biological agents during inspections. To date, 66 Ontario working exposure guidelines (See accompanying Table) with documentation have been developed since 1981. These guidelines are reviewed periodically with regard to new scientific information received and, if necessary, revised. Additions and/or deletions may be made as appropriate to the list of Ontario working exposure guidelines. Summarized in the documents are the understanding or concensus on toxicology and health effects of occupational exposures available at the time of preparation, and also the rationales for the derived working exposure guidelines. While a WEG-TWA is recommended to limit the time-weighted average exposure of a worker in an eight-hour workday or a 40-hour work-week, a WEG-MAX is the maximum exposure that should not be exceeded in any 15-minute period. The notation 'skin' following the name of a substance is included to suggest that preventive action should be taken against absorption of the substance through skin, mucous membranes or eyes. The list of Ontario working exposure guidelines has been made available to the Joint Steering Committee on Hazardous Substances in the Workplace.

For more details and information on the Ontario working exposure guidelines, write to or call:

Dr. David K.N. Leong, Ph.D., P.Eng., C.I.H.,
Chief, Resource Service,
Health and Safety Support Services Branch,
7th Floor,
400 University Avenue,
Toronto, Ontario
M7A 1T7
Canada

Tel: (416) 965-1378

Ontario Working Exposure Guidelines

No.	Hazard	Hazard Code	WEG – TWA ppm	WEG – TWA mg/m³	WEG – MAX (15-min. sample) ppm	WEG – MAX (15-min. sample) mg/m³
1	Acetophenone	98-86-2	1	5		
2	tert-Amyl Methyl Ether	994-05-8	250	1,045	310	1,295
3	Bis[2-(dimethylamino) ethyl] Ether	3033-62-3	5	33		
4	Benzaldehyde	100-52-7			4	17
5	2-Butoxyethyl Acetate – Skin	112-07-2	25	164	75	492
6	Carbon Dioxide (comfort guide in office building)	VO0124-38-9	1,000	1,800		
7	Ceramic Fibres	1302-76-7		2 fibres/cc		
8	Charcoal, Except Activated	16291-96-6		10		
9	o-Chlorobenzaldehyde	89-98-5			4	23
10	N-Coco Morpholine – Skin	1541-81-7	5	52		
11	Cotton Dust, Fabric Knitting	OH0000-15-2		0.5		
12	Cotton Dust, Slashing and Weaving	OH0000-15-0		0.75		
13	Cotton Dust, Waste	OH0000-15-1		0.5		
14	'Coumin 100' Polymer Flakes (total dust)	63393-89-5		5		
15	Cyclosol 53	OH0000-65-0		250		
16	140 Degree C Flash Aliphatic Solvent, Type of Stoddard Solvent	OH0000-64-0		525		
17	1, 3-Dichloro-2-Propanol – Skin	96-23-1	2	11		
18	Diisodecylphthalate	26761-40-0		5		10
19	3-(Dimethylamino) propylamine	109-55-7	0.5	2		

Ontario Working Exposure Guidelines

No.	Hazard	Hazard Code	WEG – TWA ppm	WEG – TWA mg/m³	WEG – MAX (15-min. sample) ppm	WEG – MAX (15-min. sample) mg/m³
20	N, N-Dimethylcyclohexylamine	98-94-2	5	26		
21	Dipropylene Glycol Monomethyl Ether Acetate	88917-22-0	100	776	150	1,164
22	N, N-Dimethylethanolamine	108-01-0	5	18		
23	Dimethyl Terephthalate	120-61-6		5		
24	Dimethyl 2, 3, 5, 6-Tetrachloroterephthalate	1861-321		5		
25	Ethyl 2-Cyanoacrylate	7085-85-0			2	10
26	Ethylene Glycol Dimethyl Ether	110-71-4	5	18		
27	Ethyl Glycol Mononitrate – Skin	16051-48-2	0.05	0.22		
28	Ethyl Methacrylate	97-63-2	100	470		
29	Forane	26675-46-7	2	15		
30	Heptyl Acetate Isomeric Mixture	90438-79-2	50	324	100	647
31	Hexamethylenetetramine (HMT)	100-97-0			0.35	2
32	Hexyl Acetate Isomeric Mixture	88230-35-7	50	295	100	590
33	Hisol 10	OH0000-52-0		250		
34	Iron Oxide (as iron)	1309-37-1		5		
35	Isopropylaminoethanols	OH0000-55-0			400	1,900
36	Kerosene	8008-20-6		100		
37	Kerosene (deodorized)	OH0000-62-0		250		
38	Lincomycin	154-21-2		0.1		
39	Lithium Hydroxide, Anhydrous	1310-65-2				1
40	Lithium Hydroxide, Monohydrate	1310-66-3				1
41	Methoxyflurane	76-38-0	2	13		
42	Mineral Spirits	OH0000-91-0		525		
43	Monobutyltin Trichloride	1118-46-3		0.1		
44	N-Methyl-2-pyrrolidone	872-50-4		400		
45	Nepheline Syenite (total dust)	37244-96-5		10		
46	Penicillin (total dust)	1406-05-9		0.1		

Ontario Working Exposure Guidelines

No.	Hazard	Hazard Code	WEG – TWA ppm	WEG – TWA mg/m³	WEG – MAX (15-min. sample) ppm	WEG – MAX (15-min. sample) mg/m³
47	Pentaerythritol Tetra-benzoate	4196-86-5				2
48	Petroleum Ether	OH0000-63-0		500		
49	2-Phenoxyethanol – Skin	122-99-6	25	141		
50	Polyvinyl Chloride Dust (total dust)	9002-86-2		1		
51	Poultry Dust (respirable dust)	RH0000-40-0		2.5		
52	Poultry Dust (total dust)	TH0000-40-0		5		
53	Propylene Glycol	57-55-6	100	311		
54	Propylene Glycol Monomethyl Ether Acetate	108-65-6	50	270		
55	Shellac Dust (total dust)	9000-59-3		10		
56	Sisal Dust (total dust)	OH0000-67-0		10		
57	Soap Dust (total dust)	68918-36-5		5		
58	Solvesso 100	OH0000-08-0		250		
59	Spectinomycin	OH0000-45-0		2		
60	Talc (containing fibres other than those of asbestos and tremolite asbestos)	C14807-96-6		2 fibres/cc*		
61	Tetrachlorophenol – Skin	25167-83-3		0.5		
62	Triethanolamine	102-71-6	10	61		
63	Triethylenediamine	280-57-9	1	4.6		
64	Triethylenetetramine – Skin	112-24-3	0.5	3		
65	Trixylylphosphate	25155-23-1		0.1		
66	Wood Dust, Not Otherwise Classified (total dust)	CH0000-01-0		3		

*Provided that the respirable dust concentration does not exceed 2 mg/m³

Coming Events

October 23–27, 1989	International Conference on Safety and Loss Prevention in the Chemical and Oil Processing Industries. SINGAPORE. For further information, contact: The Conference Co-ordinator, Applied Research Corporation, 303 Tanglin Road, Singapore 1024.
October 31– November 2, 1989	Risk Management. QUEBEC CITY, QUEBEC, CANADA. For further information, contact: APCA, P.O. Box 2861, Pittsburgh, PA, U.S.A., 15230. Telephone: (412) 232-3444.
November 6–9, 1989	International Society for Respiratory Protection. SAN FRANCISCO, CA., U.S.A. For further information, contact: Conference Co-ordinator, Janice Mathewson, 4671 Leahy St., Culver City, CA, U.S.A. 90232. Telephone: (213) 870-9121.
November 13–16, 1989	Prevention Conference IV – 'Healthy and Supportive Communities: From Commitment to Action'. TORONTO, ONTARIO, CANADA. For further information, contact: Adele Goldsmith, The Ontario Prevention Clearinghouse, 984 Bay St., Ste. 603, Toronto, Ontario, Canada, M5Z 2A5. Telephone: (416) 928-1838.
November 16–17, 1989	International Conference on Air, Water and Environmental Pollution and Hazardous Wastes. NEW DELHI, INDIA. For further information, contact: Dr. V.M. Bhatnagar, P.O. Box 1779, Cornwall, Ontario, Canada, K6H 5V7.
November 16–17, 1989	Monitoring in Industry. ANTWERP, BELGIUM. For further information, contact: TI-K VIV, Ms C. Mortelmans, Desquinlei 214, B-2018, Antwerpen, Belgium.

November 22–25, 1989	National Conference on Disaster Management 1989. HAMILTON, ONTARIO, CANADA. For further information, contact: Gary Ostofi, National Conference on Disaster Management 1989, 119 King St. West, 15th Floor, P.O. Box 910, Hamilton, Ontario, Canada, L8N 3V9. Telephone: (416) 526-2629.
November 26–29, 1989	22nd Conference on Ergonomics – Human Factors Association of Canada/Association canadienne d'ergonomie (HFAC/ACE). Metro Toronto Convention Centre, TORONTO, ONTARIO, CANADA. For further information, contact: HFAC/ACE, 6519B Mississauga Road, Mississauga, Ontario, Canada, L5N 1A6. Telephone: (416) 564-1316.
December 3–6, 1989	8th Annual Conference – Australian Institute of Occupational Hygienists. 'The Changing Face of Occupational Hygiene into the Nineties'. QUEENSLAND, AUSTRALIA. For further information, contact: AIOH 89, c/o Government Chemical Laboratories, P.O. Box 594, Archerfield, Queensland, Australia, 4108. Attention: Dr. D. Grantham. Telephone: 07/224 4221, FAX: 07/224 6098.
March 14–16, 1990	Focus on the Future: A National Conference on the Challenge of Health and Safety, CALGARY, ALBERTA, CANADA. For further information, contact: Alberta Hospital Association, Education Services, 1009 – 108 Street, Edmonton, Alberta, Canada, T5J 3C5. Telephone: (403) 423-1776, Ext. 408.
April 3–6, 1990	BOHS Annual Conference, YORK, ENGLAND. For further information, contact: BOHS, 1 St. Andrew's Place, Regent's Park, London, England, NW1 4LB. Telephone: 01-486 4860, FAX: 01-224 2576.
May 6–11, 1990	XII World Congress on Occupational Safety and Health. HAMBURG, FRG. For further information, contact: Hamburg Messe und Congress GmbH, Postbox 302480, D-2000 Hamburg 36, Federal Republic of Germany.

May 13–18, 1990	American Industrial Hygiene Conference. ORLANDO, FLORIDA, U.S.A. For further information, contact: AIHA, 475 Wolf Ledges Parkway, Akron, OH, U.S.A., 44311-1087. Telephone: (216) 762-7294.
May 20–23, 1990	FUTURESCOPE 90, GOLD COAST, AUSTRALIA. For further information, contact: National Safety Council of Australia Congress and Exposition, C/-Pacific Rim CONVENTION Systems Pty. Ltd., G.P.O. Box 853, Brisbane, Qld., Australia, 4001. Telephone: 07/221 2762, FAX: 07/220 0231.
June 19–23, 1990	6th International Conference on AIDS. SAN FRANCISCO, CALIFORNIA, U.S.A. For further information, contact: c/o NIOSH/OPPE, Building 1, Room 3040, Mailstrop D29, U.S.A.
July 2–6, 1990	Society of Occupational Medicine. EDINBURGH, SCOTLAND. For further information, contact: SOM, 6 St. Andrew's Place, Regent's Park, London, England, NW1 4LB. Telephone: 01 486 2641.
July 29–August 3, 1990	5th International Conference on Indoor Air Quality and Climate. TORONTO, ONTARIO, CANADA. For further information, contact: Centre for Indoor Air Quality Research, University of Toronto, 223 College St., Toronto, Ontario, Canada, M5T 1R4.
September 22–28, 1990	23rd International Congress on Occupational Health. MONTREAL, QUEBEC, CANADA. For further information, contact: Dr. M. Lesage, Chairman of the Organizing Committee, 84 rue de Brésoles, Montréal, Québec, Canada, H2Y 1V5.

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Ontario
Ministry of
Labour

Occupational
Health and Safety
Division

Health and Safety
Support Services
Branch

400 University Ave.
Toronto, Ontario
M7A 1T7

Telephone:
(416) 965-3610

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